

Continental Classroom

1962-63

**atomic age
physics**

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TEACHER

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INFORMATION

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Physics for the Atomic Age

PROFESSOR HARVEY E. WHITE

These lesson schedules, with suggested text book references and problem assignments, cover the lessons to be broadcast daily, Monday through Friday, over the nationwide NBC-TV network, September 24, 1962 to May 17, 1963, from 6:00 to 6:30 a.m. in each time zone.

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LESSON SCHEDULE

1st

semester

SEPTEMBER 24, 1962-JANUARY 22, 1963

KINEMATICS

September 24 LESSON 1

■ **The TV Physics Course** This will be an introduction presenting a brief outline of the course, instructions to viewers on where to write for information, and how the course is to be conducted.

September 25 LESSON 2

■ **Speed and Velocity** After a brief review of fundamental and derived units of the mks and cgs systems, the concepts of speed and velocity are explained. Uniform speed and velocity are demonstrated and the mathematical symbolism used to express instantaneous velocity is presented.

*White**: Study Secs. 2.1-2.6, 3.1-3.7; solve probs. 9, 10, 11, 12, p. 17, and 1, 2, 4, 9, 17, 20, p. 22.

September 26 LESSON 3

■ **The Experimental Method** A brief discussion of the experimental method precedes an experiment on speed and velocity. Measurements are made of a toy electric train moving along a straight track with constant velocity and around a circular track with constant speed. The viewers are asked to, and will be shown how to, record the data. Each person should have pencil and paper ready for these records. Instructions will then be given on how to calculate the results.

September 27 LESSON 4

■ **Composition of Velocities** Methods for finding the resultant motion of a body moving with two velocities simultaneously are presented. Boat and plane models are used to illustrate the basic principles of simultaneous velocities.

White: Study Secs. 12.1-12.3; solve probs. 1, 2, 5, 9, 12, p. 92.

September 28 LESSON 5

■ **Review of Trigonometry** The three basic functions of trigonometry, namely, sine, cosine, and tangent, are presented. The use of trig-tables is explained, and the laws of sines and cosines, respectively, are given.

White: Study Appendix II, pp. 721-725; solve probs. 1, 2, 5, 8, 11, 16.

October 1 LESSON 6

■ **Accelerated Motion** Uniformly accelerated motion is defined and illustrated by visual aids. The two basic equations of such motion are developed.

**For text book information see last page of this guide.*

A toy automobile is accelerated along a level plane and its average velocity is calculated from measurements made. A typical problem in accelerated motion is solved.

White: Study Secs. 4.1-4.7; solve probs. 2, 4, 9, 10, 14, 20, p. 28.

October 2 LESSON 7

■ **Experiment on Accelerated Motion** The principles of uniformly accelerated motion are demonstrated by an experiment. A small tram car moves down a wire and, while the instructor makes measurements, the viewers are expected to record the data as in lesson 3. Instructions as to the calculations to be made, and the graph to be drawn, are given. The calculations, results, and conclusions asked for in this lesson should be made within 2 days since they will be discussed in lesson 9.

October 3 LESSON 8

■ **Falling Bodies** This lesson will be given by Professor Henry Semat of City College of New York. The motion of freely falling bodies is described and illustrated. The basic equations of motions are presented and the acceleration due to gravity is given.

White: Study Secs. 5.1-5.4; solve probs. 1, 2, 4, 5, 8, 20, pp. 37, 38.

October 4 LESSON 9

■ **Experiment on Falling Bodies** The results and graphs from the experiment performed in lesson 7 are first presented as a check for those viewers who have carried out the assigned homework. The acceleration due to gravity is to be calculated from the measurements of the free fall of a steel bearing ball. The time of fall is measured with a precision stop-clock, electrically operated, and the distance is measured with a meter stick. The viewers are asked to record the data. Calculations and a graph of this data are assigned as homework, to be completed by the next lesson period.

The calculations, graph, and conclusions asked for in this lesson should be made within 2 days—they will be discussed in lesson 11.

October 5 LESSON 10

■ **Projectiles** This lesson will be given by Professor Mark Zemansky of New York City College. In the absence of air friction the paths of projectiles are shown to be parabolas. The motions of projectiles are resolved into horizontal and vertical components, and these components are shown to obey the basic kinematic equations.

White: Study Chap. 13; solve probs. 1, 5, 8, 11, 14, p. 103.

October 8 LESSON 11

■ **Mathematics and the Experimental Method** The graphs and the results of the previous experiment on falling bodies in lesson 9 are given briefly. The meaning and purpose of an algebraic equation of the simplest form, as it applies to quantitative experiments in the search for physical laws, is given. The graphical methods of representing experimental data, and the formulation of equations representing this data, are explained. A sample set of data is given and the viewer is requested to analyze this data graphically.

Plot the graphs requested at the end of this lesson and find the correct analytical equation representing the data.

White: Study Sec. 2.8; solve probs. 18, 19, 22, 23, p. 17.

LIGHT

October 9 LESSON 12

■ **Velocity of Light** Several of the earliest determinations of the velocity of light are presented. The methods used by Roemer, Fizeau, Foucault, and Michelson are explained, and then illustrated by visual aid models. The most probable value of the velocity of light is given as a result of up-to-date measurements.

White: Study Secs. 36.7-36.11; solve probs. 9, 11, 12, 14, p. 301.

October 10 LESSON 13

■ **Reflection and Refraction** The simple laws of reflection and refraction are reviewed. The reflectance of a smooth surface is given for light incident at all angles. The critical angle is determined and the conditions for total reflection are demonstrated.

White: Study Secs. 36.5, 36.6, and Chap. 37; solve probs. 15, p. 301, and 2, 4, 6, 8, p. 309.

October 11 LESSON 14

■ **Fermat's Principle** A puzzle problem is solved as an introduction to Fermat's principle. *Optical path* is defined and the path taken by light rays in reflection or refraction are shown to be a minimum, a maximum, or stationary.

Material in this lesson is found in "Fundamentals of Optics," 3rd Ed., by Jenkins and White; pub. by McGraw Hill Book Co. pp. 6-10.

October 12 LESSON 15

■ **Lenses** The properties of lenses, so basic to hundreds of optical instruments, are presented. Relations between surface curvatures and focal length, and between object and image sizes and distances are reviewed. A brief account of image defects, and how they may be reduced, is given.

White: Study Chap. 39; solve probs. 5, 8, 10, 12, 16, pp. 326, 327.

October 15 LESSON 16

■ **Diffraction** This lesson introduces the wave properties of light through Huygen's principle, and Young's double-slit experiment. Diffraction and interference of water waves is demonstrated, and simple methods of observing the same phenomena with light are explained.

White: Study Secs. 43.1-43.6; solve probs. 1, 2, 3, 8, 10, p. 360.

October 16 LESSON 17

■ **Interference** The interference of sound waves from two coherent sources is demonstrated. Angles are determined for constructive and destructive interference, and these are recorded by the viewer. An equation for Young's double-slit experiment is derived, and the viewers are asked to apply it to the experiment to find the wave length of the sound waves.

White: Study Sec. 33.4; solve probs. 10, 11, p. 270.

October 17 LESSON 18

■ **Single Aperture Diffraction** Quantitative results of the experiment performed in the previous lesson are given briefly. The diffraction pattern produced by light passing through a single aperture is explained, and a wave length formula is developed for sound waves as well as for light.

White: Study pp. 361-364; solve probs. 1, 2, 3, 4, 8, p. 368.

October 18 LESSON 19

■ **Dispersion** The deviation and dispersion of white light into a spectrum is explained and demonstrated. Dispersion curves for different optical media are shown, and the refraction of light waves at a smooth boundary is explained. The classical theory of the passage of light through solids is briefly given.

White: Study Secs. 38.1, 38.2; solve prob. 4.

October 19 LESSON 20

■ **Diffraction Gratings** This lesson will be given by Professor George R. Harrison of the Massachusetts Institute of Technology. The principles of the diffraction and interference of light by a diffraction grating are presented. The spectral orders of gratings with different line spacings are demonstrated, and the theory by which the wave lengths of light are measured with high precision is explained.

White: Study Secs. 43.7 and 43.8; solve probs. 4, 6, 7, p. 360.

October 22 LESSON 21

■ **Michelson Morley Experiment** The principles of the Michelson interferometer are presented, and its use in determining the wave length of light explained. The employment of such an instrument to test for an ether-drift, and the results of this famous experiment are explained.

White: Study Secs. 44.4, 44.5, and Chap. 46; solve probs. 10, 11, 12, p. 369, and prob. 1, p. 385.

October 23 LESSON 22

■ **Polarized Light** This lesson will be given by Professor Vernet Eaton of Wesleyan University in Middletown, Conn. The transverse character of light waves and the meaning of plane polarized light are presented. Common methods of producing plane polarized light, reflection, selective absorption, and double refraction, are described and demonstrated.

White: Study Secs. 45.1-45.2; solve probs. 1, 7, 8, 13, 14, p. 378.

October 24 LESSON 23

■ **Optical Activity** This lesson will also be given by Professor Vernet Eaton. The rotation of plane polarized light in certain types of crystals is explained and demonstrated. Circularly polarized light and the Faraday Effect are explained in terms of atomic structure of matter.

White: Study Secs. 45.3-45.6.

October 25 LESSON 24

■ **Scattering of Light** The scattering of light by molecules of a gas, and by fine suspended particles like dust, is described. The polarization of scattered light as well as the blue of the sky are explained and demonstrated.

White: Study Secs. 71.9, 45.7-45.9; solve probs. 16, 19, 20, p. 379.

October 26 LESSON 25

■ **Significant Figures, and Powers of Ten** The meaning and use of significant figures is discussed. The use of powers of ten as a means of abbreviating very large and very small numbers is illustrated by examples. The processes of the multiplication and division of numbers involving powers of ten are reviewed.

White: Study p. 728, and Secs. 2.6, 2.7; solve probs. 1, 2, p. 733, and 15, 16, 17, p. 17.

DYNAMICS

October 29 LESSON 26

■ **Newton's First and Second Laws of Motion** This lesson will be given by Professor Winston Cram of Kansas State Teachers College. The concept of inertia is introduced and demonstrated by several experiments. The force equation as it applies to the dynamics of motion is introduced, and the various units of force, mass, and acceleration are discussed.

White: Study Chap. 6; solve probs. 1, 4, 10, 14, 22, p. 47.

October 30 LESSON 27

■ **Experiment on the Force Equation** Because of the fundamental importance of the force equation, an experiment is performed. A small car with ball-bearing wheels is accelerated along a glass plate. Measurements are made of distance and time and the viewers asked to record the data.

The calculations, graph, and conclusions asked for in this lesson should be made since they will be discussed in lesson 28.

White: Study Sec. 6.4.

October 31 LESSON 28

■ **Newton's Third Law of Motion** This apparently simple law of action and reaction forces is treated in some detail. Its application to the simplest of examples indicates it is the most difficult of Newton's laws to comprehend. A clue that can serve as guide to all problems involving forces is given.

White: Study Secs. 9.3, 9.4; solve probs. 5, 8, 14, 18, 20, p. 68.

November 1 LESSON 29

■ **Weight, Mass and Force** The difference between weight and mass is explained by means of the force equation and the acceleration due to gravity. The vector representation of a force and the composition of two forces to find a resultant are treated in detail.

White: Study Secs. 6.6, 6.7, and Chap. 10; solve probs. 1, 6, 12, 20, 22, pp. 74, 75.

November 2 LESSON 30

■ **Resolution of Forces** The resolution of a force into components is presented and demonstrated. The method of components is applied to the example of a car on a steep hill, and the results are confirmed by quantitative measurements on appropriate apparatus.

White: Study Chap. 8; solve probs. 2, 8, 12, 25, 28, pp. 60-62.

November 5 LESSON 31

■ **Friction** Sliding friction is demonstrated by making a few measurements. By plotting a graph of these measurements, one drives a coefficient of sliding friction. It is shown how the angle of uniform slip may be used to determine the same coefficient.

White: Study Chap. 11; solve probs. 2, 6, 12, 20, 28, p. 84.

November 6 LESSON 32

■ **Center of Mass** The center of gravity of a system composed of one or more bodies is defined and demonstrated. The concept and meaning of *center of mass* as it applies to astronomical bodies as well as diatomic molecules is presented, and dynamic models are used as visual aids.

White: Study Chap. 17; solve probs. 2, 6, 8, 16, p. 132.

November 7 LESSON 33

■ **Work and Energy** This lesson will be given by Professor Melba Phillips of Washington University in St. Louis. The principle of work is introduced and the different systems of units commonly used for measuring work done are compared. Potential energy and kinetic energy are defined, and visual aids are used to illustrate each.

White: Study Chap. 15; solve probs. 2, 8, 16, 20, 24, pp. 119, 120.

November 8 LESSON 34

■ **Newton's Law of Gravitation** The Law of Gravitation and the Newtonian Constant of Gravitation are introduced. The famous Cavendish experiment is demonstrated with a model. Be prepared to record data. The concepts of a gravitational field, and the gravitational potential of any point in space, are developed.

White: Study Secs. 9.1, 9.2, 18.1-18.3; Calculate the results for the experiment performed, and solve probs. 2, 4, p. 68.

November 9 LESSON 35

■ **Conservation of Energy** Conservation of energy is applied to mechanical systems only, in which potential energy is converted into kinetic energy and vice versa. The principles are used to find the velocity of free fall near the earth's surface, as well as the velocity of escape from the earth.

White: Study Secs. 16.1-16.3, 18.5-18.8; solve probs. 2, 4, p. 127, and probs. 8, 10, 12, pp. 142, 143.

November 12 LESSON 36

■ **Conservation of Momentum** Conservation of momentum is applied to the motions of two bodies before and after collision with each other. The law is illustrated by several demonstrations, and the principles are applied to the elastic collision of two atoms.

White: Study Secs. 16.4-16.6; solve probs. 6, 8, 16, 20, pp. 127, 128.

November 13 LESSON 37

■ **Ballistics** This lesson will be given by Professor Paul Kirkpatrick of Stanford University. The principles of conservation of momentum and energy are applied to the bullet fired from a 22-calibre rifle. From recoil and mass measurements the muzzle velocities of several types of shells are determined. Be prepared to record data.

The calculations, results and conclusions asked for in this lesson should be made by the viewer as the homework assignment. Results will be given at the beginning of lesson 39.

November 14 LESSON 38

■ **Circular Motion** The concepts of centripetal force and centrifugal force are introduced, and their dependence upon *mass*, *speed*, and *radius* are demonstrated. The corioli's force that acts on long-range shells is considered and illustrated.

White: Study Chap. 14; solve probs. 2, 6, 18, 22, pp. 112, 113.

November 15 LESSON 39

■ **Rotating Bodies** Results of the ballistics experiment performed in lesson 37 are given first, followed by a brief discussion of orbiting satellites. The radian is introduced as the unit of angular measure in mechanics. The torque equation is introduced along with the concept of moment of inertia.

White: Study Secs. 18.4, 18.7, 19.1, 19.2; solve probs. 4, 6, 14, pp. 142, 143.

November 16 LESSON 40

■ **Angular Momentum** This lesson will be given by Professor Vernet Eaton, of Wesleyan University, Conn. Because of its fundamental importance in the motions of stars as well as atoms and molecules, the law of conservation of angular momentum is demonstrated. The *moment of inertia* and the mechanical moment of several regular shaped bodies are discussed, and the equation for rotational kinetic energy is introduced.

White: Study Chap. 21. solve probs. 2, 8, 10, 16, 22, pp. 165, 166.

Not to be telecast LESSON 41

November 19 LESSON 42

■ **Satellites and Space Travel** This lesson will be given by Willy Ley, Professor at Fairleigh-Dickenson University, New Jersey. Satellites, rockets, Kepler's laws, the Van Allen belts, and space travel will be discussed.

White: Study Chap. 18, and Sec. 73.9; solve probs. 18, 26, p. 143.

November 20 LESSON 43

■ **Crystals** This lesson will be given by Alan Holden, research scientist at the Bell Telephone Laboratories. The subjects of crystal structure, growth, cleavage, x-ray diffraction, chemical bonds, etc., will be given.

White: Study Chap. 22.

November 21 LESSON 44

■ **Hooke's Law** This Law is demonstrated by the stretching of a wire, the stretching of a spring, the bending of a uniform beam, and the twisting of a rod. The coefficient of restitution for solids is demonstrated by the bouncing of solid marbles.

White: Study Sec. 22.2, and Chap. 23; solve probs. 4, 8, 12, 16, 20, pp. 181, 182.

THANKSGIVING VACATION—OFF THE AIR November 22 and 23

November 26 LESSON 45

■ **Experiment on Elasticity** The stretching of a wire under different loads is measured by means of a mechanical lever. The viewer is asked to observe and record the measurements. The calculations and the graph asked for should be made as they will be discussed in lesson 47.

November 27 LESSON 46

■ **Vibrations and Waves** This lesson will be given by Professor Harold K. Schilling, of Pennsylvania State University, University Park, Pennsylvania. Vibration modes of bodies are described in terms of simple harmonic motion. The terms wave length, frequency, amplitude, and intensity are introduced, and the superposition of waves is discussed.

White: Study Chap. 31; solve probs. 4, 8, 14, 18, p. 254.

November 28 LESSON 47

■ **Pendulums** A general formula for the period of a body executing simple harmonic motion, the period of a simple pendulum, and a spring pendulum are given. The periods of two pendulums are determined and the viewer is asked to make certain calculations. The calculated results will be given at the beginning of lesson 48.

White: Study Secs. 31.1-31.5.

November 29 LESSON 48

■ **Resonance and Forced Vibrations** Resonance between two loosely coupled vibrating systems having the same natural frequencies is demonstrated. Forced vibration between systems of different natural frequencies, showing amplitude and phase relations, are shown by pendulums. Be prepared to record data.

White: Study Secs. 33.1, 63.4, 59.8; as homework make a graph for the experiment on forced vibrations of a pendulum.

November 30 LESSON 49

■ **Bernoulli's Principle** The paradoxical behavior of bodies in fast-moving fluids is shown by a number of demonstrations. Streamlined flow and turbulent flow are compared and the dependency of fluid friction on velocity is indicated.

White: Study Chap. 26; solve probs. 2, 4, 8, 12, p. 209.

December 3 LESSON 50

■ **Surface Tension** This lesson will be given by Professor Eric Rogers of Princeton University. Adhesion and cohesion are demonstrated, along with surface tension and the spheroidal state. A number of interesting demonstrations of change in surface tension will be shown.

White: Study Secs. 24.7-24.9; solve probs. 6, 10, 16, p. 191.

December 4 LESSON 51

■ **The Gas Laws** This lesson will be given by Professor Mark Zemansky of the City College of New York. Temperature scales will be discussed in terms of the gas laws and special thermometers. Boyle's and Charles' Laws as they apply to a gas will be discussed and demonstrated.

White: Study Secs. 27.1, 27.2; solve probs. 1, 3, 4, p. 217.

December 5 LESSON 52

■ **Kinetic Theory of Gases** This lecture will be given by Professor Mark Zemansky of the City College of New York. The molecular theory of solids, liquids, and gases is presented. The general gas law is derived from the motions of gas molecules and the pressures they produce by impact. The meaning of temperature and mean free path may be included.

White: Study Secs. 30.4, 30.5; solve probs. 10, 11, 12, p. 245.

ELECTRICITY

December 6 LESSON 53

■ **Electrostatics** Electrical charges + and — are produced and their qualitative laws of repulsion and attraction are demonstrated. Coulomb's Law and

the different units of charge are defined. Charging by induction is demonstrated and explained.

White: Study Chap. 47; solve probs. 2, 4, 8, 12, p. 395.

December 7 LESSON 54

■ **Ohm's Law** Be prepared to record data. Current is defined in terms of electrical charge flowing through a conductor. Ohm's Law is given, and simple circuits containing battery cells in series and resistors in series are discussed. Kirchhoff's law for voltage drops around a circuit is given. For your homework make the calculations for the data recorded during the last part of this lesson.

White: Study Secs. 48.1, 48.2, 48.8, 48.9, 48.10.

December 10 LESSON 55

■ **Parallel Circuits** The methods for calculating the currents flowing through resistors in series and parallel are shown; Kirchhoff's Law for currents is given.

White: Study Secs. 49.1-49.4; solve probs. 4, 6, 14, 16, pp. 410, 411.

December 11 LESSON 56

■ **Experiment on Parallel Circuits** Be prepared to record data. Resistors are connected in parallel to a battery of cells and the current through the different parts of the circuit are measured. The viewer is asked to record the voltmeter and ammeter readings and to complete the calculations from the experiment.

For your homework make the calculations requested at the end of the lesson. The results will be given at the beginning of lesson 57.

December 12 LESSON 57

■ **Variable Currents and Voltages** Be prepared to record data. The two general methods of producing different voltages and currents with one single voltage source is demonstrated. These devices are known as the potential divider or potentiometer, and the rheostat.

White: Study Secs. 49.5, 49.6, 48.9. Carry out the calculations and graph suggested at the end of this lesson.

December 13 LESSON 58

■ **Electric Fields and Potential** The meaning and definitions of electric field intensity and electrical potential are defined and illustrated. The method for producing a uniform electric field, so useful in atomic physics, is shown.

White: Study Secs. 50.1-50.4; solve probs. 2, 4, 8, 12, p. 418.

December 14 LESSON 59

■ **Energy and Power** This lesson will be given by Professor Walter C. Michels of Bryn Mawr College. The transformation of electrical energy into heat, and the calculation of electrical energy and power are the concern of this lesson.

White: Study pp. 431-433; solve probs. 2, 4, 6, 12, pp. 439, 440.

December 17 LESSON 60

■ **Capacitance** The construction and purpose of capacitors is discussed, and the equations for calculating the capacitance of various combinations of such devices is given. The effects upon capacitance produced by different dielectrics are demonstrated. Plot the graph suggested at the end of the lesson.

White: Study Secs. 50.5, 50.6; solve probs. 18, 22, 30, 32, 34, p. 419.

MAGNETISM

December 18 LESSON 61

■ **Magnetic Fields** The action of one magnet upon another is described in terms of magnetic fields around such magnets. Coulomb's Law is introduced and a brief account of the electronic origin of magnetism is explained.

White: Study Chap. 51; solve probs. 2, 4, p. 429.

December 19 LESSON 62

■ **Magnetic Induction** This lesson will be given by Professor Walter C. Michels of Bryn Mawr College. The magnetic induction around permanent magnets as well as electrically conducting wires is described and equations for the value of B are given. These formulas are of practical use in the design of apparatus for atomic research.

White: Study Secs. 51.13, 53.1, 53.2; probs. 6, 10, 14, pp. 449, 450.

December 20 LESSON 63

■ **Magnetic Dipoles** Paramagnetism and diamagnetism are introduced. The electron spin and orbital motions are shown to produce magnetic fields and magnetic dipoles. The concept of dipole moment is presented and an equation for the oscillation of a magnet in a uniform magnetic field is given.

White: Study Secs. 51.11, 53.7, 53.8, 53.9; probs. 22, 23, 24, p. 450.

December 21 LESSON 64

■ **Mechanical Forces** The mechanical force acting on current carrying wires in a magnetic field is demonstrated, and an equation for the force is derived. The torque on a current carrying loop is also derived, and the precession of an orbital-electron in a magnetic field is compared with gyroscopic precession of a top in a gravitational field.

White: Study Secs. 52.8, 52.11, 53.5, 53.6; solve probs. 20, 26, p. 440, and prob. 18, p. 450.

CHRISTMAS VACATION—OFF THE AIR

December 24 through January 1

January 2 LESSON 65

■ **Induced Currents** Induced electromotive force and current in a wire moving through a magnetic field are demonstrated. Faraday's Law is discussed, along with Lenz's Law. A formula for the emf produced in a coil rotating in a uniform magnetic field is derived.

White: Study Chap. 54; solve probs. 2, 8, 12, 16, 20, pp. 456, 457.

January 3 LESSON 66

■ **Hysteresis** The concepts of and formulas for magnetic susceptibility, permeability, and ampere turns are introduced. Energy losses due to hysteresis, and eddy currents in iron are discussed and demonstrated. Levitation is demonstrated.

White: Study Secs. 53.7, 53.8, 56.9, 56.10; probs. 12, 16, pp. 449, 450.

January 4 LESSON 67

■ **Alternating Current, Part I** This lesson will be given by Professor Hugh C. Wolfe of Cooper Union College. The concept of self induction or inductance is introduced and demonstrated. The time constant of a circuit containing inductance and resistance is defined and equations for inductive reactance and impedance are given.

White: Study Secs. 56.1-56.4; solve probs. 6, 7, 13, 14, pp. 474, 475.

January 7 LESSON 68

■ **Alternating Current, Part II** This lesson will be given by Professor Hugh C. Wolfe of Cooper Union College. Equations for capacitive reactance and impedance are given, along with phase relations between voltage and current as well as power factor.

White: Study Secs. 56.5-56.8; solve probs. 4, 15, 16, 22, pp. 474, 475.

January 8 LESSON 69

■ **Transformers** The basic principles of the open core and closed core transformer are presented. The relations between primary and secondary voltages and currents are given, as well as demonstrations of high and low voltage. Reasons for transmission of electrical energy by means of high voltage are discussed.

White: Study Chap. 55, and Sec. 56.9; probs. 2, 4, 8, 12, pp. 464, 465.

January 9 LESSON 70

■ **Experiment on Transformers** A closed core transformer with one removable leg permitting the changing of primary and secondary coils is used to measure input and output voltages. The variation of secondary voltage with number of secondary turns is determined by A. C. voltmeters. The viewer is asked to record the data and to plot a graph. Calculations should be completed by the viewer and ready for comparison in lesson 71.

January 10 LESSON 71

■ **Electromagnetic Waves** The elements of, and the formulas for frequency of, an oscillating electric circuit are given. Resonance between two high frequency circuits employing a spark discharge is demonstrated. The principles of an Hertzian oscillator are explained and the polarization of the radiation demonstrated.

White: Study Secs. 63.1-63.6; solve probs. 2, 4, 14, p. 537.

January 11 LESSON 72

■ **Vacuum Tubes** The discovery of the Edison effect and the Fleming valve are presented. The circuits for rectifying A.C. into D.C. are given and the principles of the DeForest audion explained. The development of a heated cathode and the simplified circuit diagrams for the elements of different vacuum tubes are discussed.

White: Study Secs. 63.7-63.9. and 64.1.

January 14 LESSON 73

■ **Experiment on Vacuum Tubes** Be prepared to record data. A three element vacuum tube is connected into a circuit. By means of a voltmeter and am-

meter, grid voltage and plate current readings are recorded by the viewer. The viewer is asked to plot tube characteristic curves and to calculate the voltage amplification factor. The results will be given in a later lesson.

White: Study Sec. 64.1. As homework, plot the graphs and calculate the tube amplification factor as requested at the end of the lesson. Results will be given at the beginning of lesson 74.

January 15 LESSON 74

■ **Oscillators and Amplifiers** The principles of a vacuum tube oscillating circuit are explained and the tube characteristics are used to explain a linear amplifier. The use of a thyratron for producing sweep voltages as used in oscilloscopes, radar and television is explained.

White: Study Secs. 64.2-64.4. Answer questions 1, and 2, p. 546.

January 16 LESSON 75

■ **Transistors** This lesson will be given by a guest scientist, Nobel Laureate Dr. Walter Brattain of the Bell Telephone Laboratories. You should write a one-page summary of the lecture.

White: Study Secs. 64.5-64.7. Answer question 4, p. 546.

January 17 LESSON 76

■ **Experiment on Transistors** This lesson will be given by a guest scientist, Dr. Gabriel Weinreich of the Bell Telephone Laboratories. You should write a one-page summary of the lecture and give any calculations, graphs or conclusions asked for.

White: Study Secs. 64.8-64.11. Answer questions 6, 8, 10, p. 546.

January 18 LESSON 77

■ **Radar** The principles of microwaves as used in RADAR are presented. The pulsed system of sending and receiving is explained and the various scanning methods commonly used for large area coverage are presented.

White: Study Chap. 67; answer questions 2, 4, p. 575, as homework.

Not to be telecast LESSON 78

January 21 LESSON 79

■ **Electronic Computers** This lesson will be given by Dr. Charles R. De Carlo of the International Business Machines Corporation. The principles of information storage, punched card systems, memory, disk and tape storage, and programming, will be discussed. You should write a one-page report of the lecture.

January 22 LESSON 80

■ **Inertia Guidance** This lesson will be given by a guest scientist, Dr. Charles S. Draper of the Massachusetts Institute of Technology. The use of gyroscopes and their stability characteristics as an aid to navigation will be presented. You should write a one-page report of the lecture.

White: Study Sec. 21.7.

MID-SEMESTER RECESS—OFF THE AIR January 23.

CALENDAR for Second Semester

(January 24, 1963–May 17, 1963)

■ ATOMIC PHYSICS

January

- 24 The Electron
- 25 Electronic Charge and Mass
- 28 Experiment on e/m
- 29 Photoelectric Effect
- 30 Electron Sources
- 31 Relativistic Mass and Energy

February

- 1 Positive Rays
- 4 Isotopes
- 5 Spectrographs
- 6 Kinds of Spectra
- 7 Atomic Line Spectra
- 8 The Thomson and Bohr Atoms
- 11 Electron Transitions
- 12 Elliptical Orbits
- 13 Energy Levels
- 14 The Bohr-Stoner Scheme
- 15 The Spinning Electron
- 18 The Bohr Magnetron
- 19 Spin-Orbit Interaction
- 20 The Zeeman Effect
- 21 Ionization Potentials
Washington's Birthday (February 22)
- 25 The Pauli Exclusion Principle
- 26 Vector Model for Two Electrons
- 27 X-rays
- 28 X-ray Wavelengths

March

- 1 Origin of X-rays
- 4 The Compton Effect
- 5 DeBroglie Waves
- 6 Wave Model for Atomic Structure
- 7 Electron Optics
- 8 Nuclear Spin and Hyperfine Structure
- 11 Heisenberg's Uncertainty Principle
- 12 Physics of the Solid State

■ NUCLEAR PHYSICS

- 13 Radioactivity
- 14 Alpha Rays
- 15 Range of Alpha Particles

- 18 Half-Lives of Radioactive Elements
- 19 Radioactive Series
- 20 Beta and Gamma Rays
- 21 Rutherford Scattering
- 22 Electroscopes and Geiger Counters
- 25 Geiger Counter Experiment
- 26 Wilson Cloud Chambers
- 27 Mass Spectroscopy
- 28 Induced Disintegration
- 29 The Cyclotron

April

- 1 Nuclear Reactions I
- 2 Nuclear Reactions II
- 3 Induced Radioactivity
- 4 Experiment on Induced Radioactivity
- 5 Neutron Reactions
- 8 Electron Accelerators
- 9 High Energy Atomic Accelerators
Easter Vacation (April 10–April 15)
- 16 Cosmic Rays
- 17 Positrons and Pair Production
- 18 Cosmic Ray Showers
- 19 Photo Interactions
- 22 Photographic Emulsions
- 23 Bubble Chambers
- 24 Nuclear Well Model
- 25 Nuclear Shell Structure
- 26 Molecular Beams
- 29 Scintillation and Cerenkov Counters
- 30 Nuclear Resonance

May

- 1 Radioactive Tracer Isotopes
- 2 Nuclear Binding Energies
- 3 Nuclear Cross-Sections
- 6 Discovery of Fission
- 7 Fission Fragments
- 8 Chain Reactions
- 9 Atomic Pile
- 10 Transuranium Elements
- 13 Nuclear Power
- 14 Solar Energy
- 15 Fusion of Light Nuclei
- 16 Elementary Particles
- 17 Highlights of This Course in Retrospect

LESSON SCHEDULE

2nd semester

JANUARY 24, 1963-MAY 17, 1963

ATOMIC PHYSICS

January 24 LESSON 81

■ **The Electron** This lesson begins with the early experiments dealing with the discovery of the electron made through a study of cathode rays. Demonstrations are given to show that electrons are negatively charged particles and when moving have momentum and kinetic energy. Write a one-page summary of this lesson.

White: Study Secs. 57.1, 57.2.

January 25 LESSON 82

■ **Electronic Charge and Mass** Experiments on the value of e/m , as first determined by J. J. Thomson, and the electronic charge, by R. A. Millikan, are presented. Equations for the bending of the path of charged particles in electric and magnetic fields are given.

White: Study Sec. 57.3-57.6; solve probs. 2, 4, 6, p. 483.

January 28 LESSON 83

■ **Experiment on e/m** A beam of electrons are deflected in the uniform magnetic field generated by Helmholtz coils. Measurements of the accelerating voltage, magnetic field current, and path radius, result in determinations of the electronic charge-to-mass ratio. The calculations and results of this experiment are left for the student to carry out as a lesson assignment.

White: Study Secs. 57.3, 57.4, and calculate e/m from the data recorded in the lecture.

January 29 LESSON 84

■ **Photoelectric Effect** The results of the experiment performed in Lesson 83 are given. This is followed by a brief account of the discovery of the photoelectric effect, and the interpretation of the phenomenon in terms of the Einstein photoelectric equation. Millikan's determination of Planck's constant h is discussed.

White: Study Secs. 61.1-61.8; solve probs. 2, 4, 8, p. 517.

January 30 LESSON 85

■ **Electron Sources** Thermionic emission from heated metal surfaces is discussed, along with secondary electron emission. The principles of field emission and photomultiplier tubes are given. Write a one-page summary of this lesson.

White: Study Secs. 63.7, 61.1, 61.9; solve probs. 10, 11, 12, p. 517.

January 31 LESSON 86

■ **Relativistic Mass and Energy** This lesson will be given by Professor Henry Semat of the City College of New York. The Michelson-Morley experiment and relative velocities will first be discussed. The change in mass with velocity is discussed in detail. Equations relating mass, velocity, momentum, and accelerating voltage are given, and the mass energy equation $E = mc^2$.

White: Study Secs. 44.6, and Chap. 46; probs. 6, 8, 10, 12, p. 385.

February 1 LESSON 87

■ **Positive Rays** The discovery of positive rays by Goldstein in 1895, and the discovery of isotopes by J. J. Thomson in 1912 is discussed. Write a one-page summary of this lesson.

White: Study Secs. 58.1-58.4; solve probs. 2, 5, p. 492.

February 4 LESSON 88

■ **Isotopes** The Aston, and the Bainbridge mass spectrographs are discussed, as well as the relative abundance of the isotopes of a number of elements. The structure of the atom as made up of neutrons, protons, and electrons is presented. This lesson will be given by Dr. Elmer Hutchisson. Write a one-page summary of this lesson.

White: Study Secs. 85.5-85.7; solve probs. 8, 9, 12, p. 493.

February 5 LESSON 89

■ **Spectrographs** Prism spectroscopes and spectrographs are shown and discussed. The use of the reflection type grating is explained along with the devices for studying the ultra-violet and infrared spectrum as well as the visible spectrum. Record the measurements made in this experiment performed near the end of the lecture and calculate the wavelength of light as your homework.

White: Study Secs. 43.6-43.8, 59.2, 59.3.

February 6 LESSON 90

■ **Kinds of Spectra** The Stefan-Boltzmann Law, as well as Wien's Displacement Law, is discussed in connection with black body radiation. Line emission and line absorption spectra are demonstrated. Photographs of line and band spectra are shown.

White: Study Chap. 59; solve probs. 1, 2, 3, 5, 7, p. 501.

February 7 LESSON 91

■ **Atomic Line Spectra** The Balmer series of spectrum lines in the visible spectrum from hydrogen is shown. Along with this the sharp, principal, and diffuse series of spectrum lines arising from the alkali metals is discussed. The Balmer formula for hydrogen, and the Rydberg formula for other series are given.

White: Study Secs. 59.6, 59.10, 66.3; solve probs. 11, 12, 13, p. 501, and probs. 7, 8, p. 567.

February 8 LESSON 92

■ **The Thomson and Bohr Atoms** The early shell model of the atom first proposed by Thomson is demonstrated. The Bohr atom model for hydrogen is

introduced and equations for the electron orbit size and velocity are developed. Write a one-page summary of this lesson.

White: Study Secs. 60.1, 60.2; solve probs. 1, 2, 11, p. 510.

February 11 LESSON 93

■ **Electron Transitions** Bohr's assumption regarding electron jumps from orbit to orbit is discussed in detail. His derived equation is shown to fit the already known Balmer series of hydrogen and to predict additional series of lines in the ultraviolet and infrared spectrum.

White: Study Secs. 60.3-60.8; solve probs. 4, 6, 8, 12, p. 510.

February 12 LESSON 94

■ **Elliptical Orbits** The introduction of elliptical orbits into the Bohr theory of hydrogen is given in some detail. This introduces two quantum conditions and two quantum numbers to atomic structure. The notation, s., p. d., etc., for the azimuthal quantum number is shown to be associated with the electrons orbital angular momentum. Write a one-page summary of this lesson.

White: Study Sec. 60.9.

February 13 LESSON 95

■ **Energy Levels** Energy level diagrams for hydrogen atoms and sodium atoms are drawn and discussed. It is shown how energy levels are specified in terms of units called *wave numbers*. Emission and absorption are indicated by arrows on an energy level diagram. Write a one-page summary of this lesson.

White: Study Secs. 60.6, 66.4, 66.5, 66.6; questions 2, 4, 6, p. 566.

February 14 LESSON 96

■ **The Bohr-Stoner Scheme** The shell and sub-shell structure of the atoms of the periodic table are taken up in detail. The rules for assigning these electrons to the various shells are given, along with some discussion of the orbit sizes and shapes. Write a summary of this lesson.

White: Study Secs. 60.8, 60.9.

Not to be telecast LESSON 97

February 15 LESSON 98

■ **The Spinning Electron** The concept of a spinning electron is introduced to explain the doubling of the energy levels of atoms containing one valence electron. The spin angular momentum, coupled with the orbital angular momentum, gives rise to another quantum condition and a third quantum number j . This lesson will be given by Dr. P. Kusch, Nobel Laureate in Physics, 1955. Write a summary of this lesson.

White: Study Secs. 66.4, 66.5.

February 18 LESSON 99

■ **The Bohr Magneton** Due to its negative charge an orbital electron is shown to have a magnetic moment. Having both a magnetic moment and a mechanical moment such an orbit will precess when placed in a magnetic field. This is analogous to the precession of a top in a gravitational field. The Bohr Magneton is defined as an atomic unit of magnetic moment. Write a one-page summary of this lesson.

White: Study Secs. 66.1-66.3, 53.9. Answer question 1, p. 566.

February 19 LESSON 100

■ **Spin-Orbit Interaction** The orbital motion and spin of the electron are shown to be coupled together by quantum conditions. Due to the magnetic field at the electron, produced by the presence of a positively charged nucleus, the atom is in its lowest energy state when the spin angular momentum is opposite in direction to the orbital angular momentum. Write a one-page summary of this lesson.

White: Study Secs. 66.4-66.5.

February 20 LESSON 101

■ **The Zeeman Effect** When a light source is placed in a strong magnetic field each spectrum line is split up into a pattern of several lines. On the semiclassical picture of the atom this is due to the precessional motion of the entire atom around the field direction, and this in turn splits each energy level into component levels. The magnetic quantum number is introduced to account for these levels. Write a one-page summary of this lesson.

White: Study Sec. 66.6; answer questions 4, 9, p. 567.

February 21 LESSON 102

■ **Ionization Potentials** The ionization potential of an atom is defined and explained. The Franck and Hertz experiments of 1914 are described, in which the excitation as well as ionization potential of sodium were determined. A plate of the ionization potentials of all elements shows the shell type structure of atoms. Write a summary of this lesson.

White: Study Sec. 66-8-66.10; solve probs. 10, 11, p. 567.

WASHINGTON'S BIRTHDAY—OFF THE AIR February 22.

February 25 LESSON 103

■ **The Pauli Exclusion Principle** The Pauli exclusion principle is explained as the determining factor for the maximum number of electrons found in each shell of an atom. Completed electron shells are shown to have zero angular momentum. Write a summary of this lesson.

White: Study Secs. 60.8, 66.7; answer question 3, p. 567.

February 26 LESSON 104

■ **Vector Model for Two Electrons** Atoms containing two valence electrons are shown to give rise to singlet and triplet energy levels. These are due to the strong coupling between the electron orbits as well as between the electron spins to form L and S values. These resultant orbital and spin values couple more meekly to form J, the resultant quantum number specifying the total angular momentum of the electrons. Write a summary of this lesson.

Not to be telecast LESSON 105

Not to be telecast LESSON 106

February 27 LESSON 107

■ **X-rays** The discovery of X-rays and the development of X-ray tubes are first presented. This is followed by explanations of how X-ray photographs are made, and of how the wave properties of X-rays were first established by "Laue diffraction patterns." Write a one-page summary of this lesson.

White: Study Secs. 62.1-62.4, 75.9; questions 1, 2, 3, 4, 5, 6, 7, p. 526.

February 28 LESSON 108

■ **X-ray Wavelengths** The Bragg formula for X-ray crystal diffraction is derived, and X-ray spectograms are discussed and interpreted. The origin of X-ray line spectra is presented along with the Moseley Law establishing the order of the elements in the periodic table.

White: Study Secs. 62.5, 62.6; solve probs. 2, 4, 6, pp. 526, 527.

March 1 LESSON 109

■ **Origin of X-rays** The origin of Bremsstrahlung as well as line spectra is explained. The highest X-ray frequencies are shown to depend upon the applied voltage, and the concept of X-ray energy levels is introduced.

White: Study Secs. 62.6, 62.7; answer question 8, p. 526.

March 4 LESSON 110

■ **The Compton Effect** X-ray absorption curves are drawn for absorbers of different thicknesses. The scattering of X-rays and the Compton effect is discussed in detail. The laws of conservation of energy and momentum are shown to apply to the collision between photons and electrons. Photons are shown to change frequency and electrons recoil with kinetic energy. Plot an absorption curve and make the calculations suggested in this lesson. The results will be given in lesson 111.

White: Study Secs. 71.9, 68.2; solve probs. 1, 12, p. 585.

March 5 LESSON 111

■ **DeBroglie Waves** According to DeBroglie's hypothesis every moving atomic particle has an associated wave length. These wave properties account for electron refraction as well as diffraction. The Davisson-Germer experiment is described by means of the DeBroglie wave equation.

White: Study Secs. 68.3, 65.1, 68.4; solve probs. 4, 6, 8, p. 585.

March 6 LESSON 112

■ **Wave Model for Atomic Structure** Electron waves in the Bohr orbits of hydrogen are shown to set up standing waves, with nodes and antinodes. The model is extended to the three dimensional atom in which the standing waves become analogous to spherical harmonics, and graphs are used to show the shapes of the nodes and loops. Write a one-page summary of this lesson.

White: Study Secs. 68.6, 68.7.

March 7 LESSON 113

■ **Electron Optics** This lesson will be given by Dr. Albert Rose of the Radio Corporation of America. Electron lenses of various kinds are discussed along with the principles of an electron gun. Write a summary of this lesson.

White: Study Secs. 65.1-65.8.

March 8 LESSON 114

■ **Nuclear Spin and Hyperfine Structure** The fact that many spectrum lines show hyperfine structure is attributed to what is called the spin of the atomic nucleus. Because the nuclear mass giving rise to the spin is large compared to the electronic mass, the splitting up of energy levels as the result of a nuclear spin is a great deal smaller than the fine structure splitting due to electron spin. Write a summary of this lesson.

White: Study Secs. 77.7, 77.8, 77.9; solve probs. 7, 8, p. 679.

March 11 LESSON 115

■ **Heisenberg's Uncertainty Principle** The apparent duality between the wave and corpuscular nature of electro-magnetic waves and atomic particles is explained by means of Heisenberg's uncertainty principle. The diffraction of atomic particles as well as light waves is explained. Write a summary of this lesson.

White: Study Sec. 68.8.

March 12 LESSON 116

■ **Physics of the Solid State** This lesson will be given by Professor Frederick Seitz of the University of Illinois. The various physical properties of solids is explained in terms of the atomic structure of solids. As an assignment you should write a one-page summary of the lesson.

NUCLEAR PHYSICS

March 13 LESSON 117

■ **Radioactivity** The discovery of the penetrating radiation from uranium and other heavy elements by Becquerel, the Curies, and others is related. The properties of α , β , and γ -rays are compared, along with their identification with atoms and electromagnetic waves. Be prepared to record data from an experiment to be performed in this lesson. The results will be given at the beginning of lesson 118.

White: Study Secs. 69.1-69.7; Plot the graph suggested in the lecture.

March 14 LESSON 118

■ **Alpha Rays** Early experiments on the E/M value of alpha rays are described. The identification of the particles as helium nuclei is explained as the result of a spectrum analysis, and the charge they carry is explained as the result of direct measurements from sources of known activity. Be prepared to record data from an experiment to be recorded in this lesson. The results will be given at the beginning of lesson 119.

White: Study Sec. 69.3; Plot the graph and make the calculations asked for in this lesson.

March 15 LESSON 119

■ **Range of Alpha Particles** The methods used in finding the ranges of alpha particles from different radioactive elements are described. The range of the alpha particles from a radioactive element is determined by experiment. Be prepared to record data.

White: Study Secs. 69.8, 69.9; Plot the graph and from it determine the range of the alpha particles.

March 18 LESSON 120

■ **Half-Lives of Radioactive Elements** The meaning of the half-life of a radioactive element is explained. Graphs are drawn of typical decay curves, and the average life-time is defined. An experiment is performed with thorium emanation. Be prepared to record data.

White: Study Secs. 70.1, 70.2; Plot the graph requested and determine the half life of thoron.

March 19 LESSON 121

■ **Radioactive Series** This lesson will be given by Professor John F. Baxter of the University of Florida. The emission of alpha, beta, and gamma rays among the heavy elements has been arranged into four radioactive series of elements. Three of these series are shown to end on the three lead isotopes 206, 207 and 208.

White: Study Sec. 70.3, and p. 736; and solve probs. 6, 7, 8, 9, 10, 11, 12, p. 604.

March 20 LESSON 122

■ **Beta and Gamma Rays** Beta rays emitted by a radioactive element are shown to have a continuous velocity distribution with a high energy limit or end point. Such distributions are explained by the introduction of the neutrino. The emission of gamma rays is compared with the emission of light in the outer electron structure of atoms. Discrete beta ray energies are described as internal conversion of gamma rays.

White: Study Secs. 71.1-71.4; solve probs. 1, 2, 3, 4, p. 613.

March 21 LESSON 123

■ **Rutherford Scattering** The scattering of alpha particles by thin metal foils is described in detail. The failure of the Thomson atom to explain large angle scattering led Rutherford to the nuclear atom. A mechanical model is used to demonstrate scattering at different velocities and angles. The nuclear radius is calculated from Rutherford's experimental results.

White: Study Secs. 72.1, 72.2; solve probs. 2, 3, p. 624.

March 22 LESSON 124

■ **Electroscopes and Geiger Counters** The dissipation of energy by high speed atomic particles as they pass through matter is discussed. Several kinds of electroscopes are described along with the basic principles of the Geiger-Mueller counter. The plateau characteristic of a Geiger-Mueller tube is demonstrated. Be prepared to record data.

White: Study Sec. 73.4; Plot the plateau curve requested in lesson.

March 25 LESSON 125

■ **Geiger Counter Experiment** A Geiger Counter is used to detect rays from a radium source. An experiment using two comparable sources, one at a time and then together, is performed. From the results, and the proper equations given, the viewer is asked to calculate the dead-time, and the corrected counting rates. Take careful notes on the dead-time concept and record the data taken with the Geiger counter.

As homework determine the dead-time and calculate the correct counts per minute for the recorded C/M.

March 26 LESSON 126

■ **Wilson Cloud Chambers** The principles of a Wilson cloud chamber are demonstrated by the formation of fog in a glass jar. Visible tracks are produced with alpha particles from a radium source. Expansion type cloud chambers as well as continuous types are shown and discussed.

White: Study Sec. 69.7; write a one page summary of this lesson.

March 27 LESSON 127

■ **Mass Spectroscopy** This lesson will be given by Professor Kenneth Bainbridge of Harvard University. Descriptions of precision mass spectrographs will be given along with the use of isotopic pairs for determining atomic masses with great accuracy. A one-page summary of this lesson should be written by the student.

March 28 LESSON 128

■ **Induced Disintegration** Rutherford's experimental observations on alpha particle ranges in different gases are described. Elastic collisions between alpha particles and other atomic nuclei are explained along with Rutherford's discovery of the disintegration of nitrogen nuclei. Chadwick's discovery of the neutron is described as well as the Cockcroft-Walton experiment of the proton disintegration of lithium. A one-page summary of this lesson should be written by the student.

White: Study Secs. 72.3-72.9; solve probs. 4, 6, 8, 14, p. 624.

March 29 LESSON 129

■ **The Cyclotron** The development of the first cyclotron by Lawrence and Livingston is explained. The simple theory of such an accelerator is given, along with a demonstration with a mechanical cyclotron. A one-page summary should be written for this lesson.

White: Study Secs. 74.1-74.4; answer questions 1, 2, 3, 4, 5, p. 647.

April 1 LESSON 130

■ **Nuclear Reactions I** Several nuclear reactions produced by protons and deuterons from the cyclotron are discussed, as well as the fact that the atomic masses are not exactly whole number multiples of unit atomic mass. The general equation for atomic energy is briefly introduced, and the energy of unit atomic mass is calculated in Mev. Write a one-page summary for this lesson.

White: Study Sec. 75.1, Eq. (701), Secs. 72.8, 72.9.

April 2 LESSON 131

■ **Nuclear Reactions II** Disintegration of a few light elements by alpha particles are discussed. Mass-energy relations and the balancing of reaction equations are presented in detail. The subsequent recoils of particles from disintegration are given briefly. Write a one-page summary of this lesson.

White: Study Secs. 75.2, 75.3.

April 3 LESSON 132

■ **Induced Radioactivity** The experiment by which induced radioactivity was discovered by F. Joliot and I. Curie is described in detail. Activity giving rise to positions is also presented along with a description of nuclear changes that take place. Mass energy relations for positron emission are given. Write a one-page summary of this lesson.

White: Study Secs. 75.4-75.6; solve prob. 6, p. 658.

April 4 LESSON 133

■ **Experiment on Induced Radioactivity** In this experiment a target will be bombarded by high speed atomic particles and made radioactive. The activity

will be measured over a period of time. The viewer is asked to plot a decay curve and from it determine the half-life of the element in question. Be prepared to record data in this lesson.

White: Study Secs. 76.1-76.3; using the data recorded in this experiment calculate the true counts per minute, plot a semi-log graph, and determine the two half-lives of the two silver isotopes.

April 5 LESSON 134

■ **Neutron Reactions** The discovery by Feather of disintegration by neutron bombardment is presented, along with slow neutron disintegration discovered and developed by Fermi. The conversion of neutrons into protons and electrons, as well as neutron-gamma ray reactions are included. Write a one-page summary of this lesson.

White: Study Secs. 76.1-76.4; solve probs. 2, 4, 6, 8, p. 669.

April 8 LESSON 135

■ **Electron Accelerators** Electron accelerators starting with the electron gun, and Van de Graaff generators are described. The principles of the betatron and synchrotron are presented. This lesson will be given by Dr. D. W. Kerst of the University of Illinois. Write a one-page summary of this lesson.

White: Study Sec. 74.4.

April 9 LESSON 136

■ **High Energy Atomic Accelerators** The principles of the proton synchrotron and synchro-cyclotron are presented. These high energy particle accelerators are briefly described and the objectives for which they were designed are discussed. The linear accelerator principles are also presented. Write a one-page summary of this lesson.

White: Study Secs. 74.3, 74.5-74.8; solve probs. 8, 9, 10, p. 647.

EASTER VACATION—OFF THE AIR April 10-April 15.

April 16 LESSON 137

■ **Cosmic Rays** The historical discoveries leading to the identification of cosmic rays are related. This is followed by a brief account of the latitude effect and its implications. A cosmic ray telescope composed of two or more Geiger counter tubes connected in coincidence is explained. Write a one-page summary of this lesson.

White: Study Secs. 73.1-73.9; answer questions 1, 2, 3, 4, p. 637.

April 17 LESSON 138

■ **Positrons and Pair Production** The experiments leading to the discovery of the positron will be described. The production of electron pairs in solids and gases will be shown by photographs. This lesson will be given by guest scientist C. D. Anderson, Professor of Physics, and Nobel Laureate in Physics, 1936. Write a one-page summary of the material presented.

White: Study Secs. 73.10, 73.11.

April 18 LESSON 139

■ **Cosmic Ray Showers** The shower-producing process is described and photographs of showers taken with cloud chambers are shown. Primary and secondary cosmic rays as well as the kinds of particles encountered at high altitudes will be discussed. You should write a one-page summary of this lesson.

White: Study Secs. 73.12, 73.13; answer questions 5, 6, 7, 8, 9, p. 637.

April 19 LESSON 140

■ **Photo Interactions** The interaction of nuclei by high energy gamma rays, or X-rays, from an electron accelerator and target is discussed. The competing processes of Compton recoil electrons, electron pair production, and the creation of pi mesons, singly or in pairs, are briefly presented. A summary of this lesson should be written as a report to be handed in by the student.

White: Study Secs. 76.5-76.7; solve probs. 10, 12, p. 669.

April 22 LESSON 141

■ **Photographic Emulsions** The role of the photographic emulsion as a means of studying nuclear collisions, and resulting disintegration fragments, is presented. A number of interesting pictures of nuclear events will be shown and their interpretation given. A one-page summary of this lesson should be written by the student.

White: Study Secs. 75.8, 80.6.

April 23 LESSON 142

■ **Bubble Chambers** The bubble chamber is described as a device, similar to the Wilson Cloud Chamber as well as photographic emulsions, for studying the nuclear collisions and reactions. Because of the high density of liquids, high energy tracks are compressed into a small volume of space. This lesson will be given by Dr. Donald A. Glaser of the University of Michigan, Nobel Laureate in Physics, 1961. A one-page summary of this lesson should be written by the student.

White: Study Sec. 80.7.

April 24 LESSON 143

■ **Nuclear Well Model** Various models of the atomic nucleus will be presented, with emphasis on the nuclear well model. Demonstrations of the capture process, as well as the disintegration process will be given. The relation between half-life and the pseudo-temperature of an excited nucleus will be shown. A one-page summary of this lesson should be written by the student.

White: Study Secs. 77.3-77.6.

April 25 LESSON 144

■ **Nuclear Shell Structure** The nuclear shell structure model of the atomic nucleus will be discussed. The role of magic numbers and nuclear spin in the formulation of this model will be given. A one-page summary of this lesson should be written by the student.

White: Study Secs. 75.7, 77.1, 77.2, 77.10.

April 26 LESSON 145

■ **Molecular Beams** The use of molecular beams as a means for determining the nuclear spins and magnetic moments will be presented. This involves the deflections of atomic particles in magnetic fields that are fixed and others that periodically reverse at high frequencies. This lesson will be given by Dr. I. I. Rabi, of Columbia University, Nobel Laureate in Physics, 1944. A one-page summary should be written by the student.

April 29 LESSON 146

■ **Scintillation and Cerenkov Counters** The use of fluorescence in the design and operation of the scintillation counters will be explained. Quantitative measures of radioactive sources will be made and the viewer will be asked to participate in the experiment by recording the data. The calculations necessary to complete an experimental report should be carried out as a homework assignment. The results of this experiment will be given in lesson 148. A brief description of Cerenkov radiation and its use in counter devices will be given.

White: Study Secs. 71.6, 71.7, 71.9, 71.10.

April 30 LESSON 147

■ **Nuclear Resonance** The use of high frequency magnetic field as a means of finding the natural frequencies of atomic nuclei will be explained. The meaning of relaxation time and the determination of nuclear magnetic moments will also be given. This lesson will be given by Dr. Felix Block, of Stanford University, Nobel Laureate in Physics, 1952. A one-page summary should be written on the material presented.

May 1 LESSON 148

■ **Radioactive Tracer Isotopes** Of the many radioactive isotopes of the known chemical elements, certain ones are found useful as tracers. The use of such tracer isotopes in various branches of research and development will be explained and some demonstrated. An experiment is performed to determine the rate at which celery and tomato plants take up phosphate containing radioactive phosphorus.

White: Study Sec. 75.8.

May 2 LESSON 149

■ **Nuclear Binding Energies** Graphs of the phosphate uptake by plants are given at the beginning of the lesson. The binding energies of nuclei, as shown by disintegration measurements as well as atomic mass measurements, will be considered in detail. The relations between stable and unstable nuclear masses will be pointed out. Packing fractions and nuclear binding energy curves will be shown for the entire periodic table. A one-page summary of this lesson should be written by the student.

White: Study Secs. 77.1, 77.2, 75.7; solve probs. 2, 3, 4, p. 679.

May 3 LESSON 150

■ **Nuclear Cross-Sections** The cross-sections of atomic nuclei, as targets for low and high energy atomic particles will be discussed. The role of the scattering process in determining these cross-sections will be explained. A one-page summary of this lesson should be written by the student.

White: Study Secs. 79.2, 76.3, Fig. 79M, and Sec. 77.3; solve probs. 2, 3, p. 703.

May 6 LESSON 151

■ **Discovery of Fission** Dr. Lisa Meitner, co-discoverer of fission will be interviewed by Professors White and Michels, during the first five minutes. The discovery of fission and the early experiments in this subject will be taken up. The various methods by which the fission process can be induced are explained. A one-page summary of this lesson should be written.

White: Study Sec. 78.1; solve probs. 1, 2, 4, p. 689.

May 7 LESSON 152

■ **Fission Fragments** The distribution of fission fragments among the elements of the periodic table will be given in more detail than in the preceding lesson. The process of spallation will also be considered.

White: Read Secs. 78.1-78.3.

May 8 LESSON 153

■ **Chain Reactions** The chain reaction created in a given quantity of uranium will be discussed. The meaning of critical mass and the explosive properties of concentrated masses of U-235 and Pu-239 will be taken up. Fission cross-sections and mean-free-path will be discussed.

White: Study Secs. 79.1, 79.4-79.6; solve probs. 8, 10, p. 703.

May 9 LESSON 154

■ **Atomic Pile.** The general principles of nuclear reactors and the atomic piles are discussed and a model is used for demonstration. The various types of reactors are considered along with their general uses. The effects of a moderator will be demonstrated with a neutron source, paraffin, and borax.

White: Study Sec. 79.7; solve probs. 4, 6, p. 703.

May 10 LESSON 155

■ **Transuranium Elements** The elements beyond uranium-92 are taken up in detail. The production of these elements, how they are identified and how they were named, will be explained. It is planned that this lesson be given by Dr. Glenn Seaborg, Chairman, Atomic Energy Commission and Nobel Laureate in Chemistry, 1951. A one-page summary of this lesson should be written by the student.

White: Study Secs. 78.4-78.6; solve probs. 5, 6, 7, p. 689.

May 13 LESSON 156

■ **Nuclear Power** The general use of the atomic pile as a source of thermal energy will be considered. Some of the problems connected with such power units, and the protection of operating personnel will be included. Different types of reactors are discussed, along with some details of the nuclear powered passenger-cargo ship Savannah. A model of a nuclear powered submarine armed with polaris missiles is shown. Peacetime uses of atomic energy are given.

White: Study Secs. 79.8, 79.9.

May 14 LESSON 157

■ **Solar Energy** The question of the origin of solar energy is presented. The proton-proton and carbon cycles proposed to explain solar energy are given, and mass annihilation calculations are compared with the solar mass. A one-page summary of this lesson should be written by the student.

White: Study Secs. 28.7, 28.7; solve probs. 8, 9, p. 689.

May 15 LESSON 158

■ **Fusion of Light Nuclei** The use of fission to obtain the high temperatures required to produce fusion is briefly explained. The possible liberation of energy from elements other than hydrogen is also discussed, as well as the attempts being made to produce fusion under a controlled process. Film clips of a number of the nation's research laboratories experimenting of controlled fusion will be shown.

White: Study Secs. 78.7, 79.10, 79.11.

May 16 LESSON 159

■ **Elementary Particles** A list of the known elementary atomic particles will be presented and along with them their various properties, mass, charge, and spin. Theoretical considerations of these various particles and the meaning of anti-particles will be given. This lesson will be given by Dr. Edwin McMillan, of the University of California, Nobel Laureate in Chemistry, 1951.

White: Study Chap. 80; solve probs. 2, 4, 6, 8, 10, pp. 717, 718.

May 17 LESSON 160

■ **Highlights of This Course in Retrospect** A resume of some of the highlights of this course will be given. This will include some of the production problems encountered in TV presentation, its reception by the mass audience, and the coordination of more than 200 accredited colleges and universities giving credit to thousands of student teachers enrolled in the course. The growing use of TV in education in general will be briefly evaluated.

GUEST LECTURERS

october	3	Dr. Henry Semat <i>Professor of Physics, The City College, New York, N.Y.</i> —Lesson 8, <i>Falling Bodies</i>
october	5	Dr. Mark Zemansky <i>Professor and Chairman of Department of Physics, The City College, New York, N.Y.</i> —Lesson 10, <i>Projectiles</i>
october	19	Dr. George R. Harrison <i>Dean of Science, Massachusetts Institute of Technology, Cambridge, Mass.</i> —Lesson 20, <i>Diffraction Gratings</i>
october	23	Dr. Vernet Eaton <i>Professor of Physics, Wesleyan University, Middletown, Conn.</i> —Lesson 22, <i>Polarized Light</i> —Lesson 23, <i>Optical Activity</i>
october	24	Dr. S. Winston Cram <i>Professor of Physics, Kansas State Teachers College, Emporia, Kan.</i> —Lesson 26, <i>Newton's First and Second Laws of Motion</i>
october	29	
november	7	Dr. Melba Phillips <i>Professor of Physics, Washington University, St. Louis, Mo.</i> —Lesson 33, <i>Work and Energy</i>
november	13	Dr. Paul Kirkpatrick <i>Professor of Physics, Stanford University, Palo Alto, Cal.</i> —Lesson 37, <i>Ballistics</i>
november	16	Dr. Vernet Eaton —Lesson 40, <i>Angular Momentum</i> Willy Ley <i>Professor of Physics, Fairleigh Dickinson University, Madison, N. J.</i> —Lesson 42, <i>Satellites and Space Travel</i>
november	19	
november	20	Alan Holden <i>Research Physicist, Bell Telephone Laboratories, Murray Hill, N. J.</i> —Lesson 43, <i>Crystals</i>
november	27	Dr. Harold K. Schilling <i>Professor of Physics, Pennsylvania State University, University Park, Penn.</i> —Lesson 46, <i>Vibrations and Waves</i>
december	3	Eric Rogers <i>Professor of Physics, Princeton University, Princeton, N. J.</i> —Lesson 50, <i>Surface Tension</i>
december	4	Dr. Mark Zemansky —Lesson 51, <i>The Gas Laws</i> —Lesson 52, <i>Kinetic Theory of Gases</i>
december	5	
december	14	Dr. Walter Michels <i>Professor of Physics, Bryn Mawr College, Bryn Mawr, Penn.</i> —Lesson 59, <i>Energy and Power</i> —Lesson 62, <i>Magnetic Induction</i>
december	19	Dr. Hugh C. Wolfe <i>Professor of Physics, Cooper Union Institute, New York, N.Y.</i> —Lesson 67, <i>Alternating Current I</i> —Lesson 68, <i>Alternating Current II</i>
january	4	
january	7	Dr. Walter Brattain* <i>Research Physicist, Bell Telephone Laboratories, Murray Hill, N. J.</i> —Lesson 75, <i>Transistors</i> Dr. Gabriel Weinreich <i>Research Physicist, Bell Telephone Laboratories, Murray Hill, N. J.</i> —Lesson 76, <i>Transistors</i>
january	15	
january	17	Dr. Charles DeCarlo <i>Research Mathematician, International Business Machines, White Plains, N. Y.</i> —Lesson 79, <i>Electronic Computers</i> Dr. Charles S. Draper <i>Professor of Physics, Massachusetts Institute of Technology</i> —Lesson 80, <i>Inertial Guidance</i>
january	21	
january	22	

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GUEST LECTURERS

january	31	Dr. Henry Semat —Lesson 86, <i>Relativistic Mass and Energy</i>
february	4	Dr. Elmer Hutchisson <i>American Institute of Physics, New York, N.Y.</i> —Lesson 88, <i>Isotopes</i>
february	15	Dr. P. Kusch* <i>Professor of Physics, Columbia University, New York, N.Y.</i> —Lesson 98, <i>The Spinning Electron</i>
march	7	Dr. Albert Rose <i>Research Physicist, R. C. A. Laboratories, Princeton, N. J.</i> —Lesson 113, <i>Electron Optics</i>
march	12	Dr. Frederick Seitz <i>Professor of Physics, University of Illinois, Urbana, Ill.</i> —Lesson 116, <i>Physics of the Solid State</i>
march	27	Dr. K. T. Bainbridge <i>Professor of Physics, Harvard University, Cambridge, Mass.</i> —Lesson 127, <i>Mass Spectroscopy</i>
april	8	Dr. D. W. Kerst <i>General Dynamics Corporation, San Diego, Cal.</i> —Lesson 135, <i>Electron Accelerations</i>
april	17	Dr. C. D. Anderson* <i>Professor of Physics, California Institute of Technology, Pasadena, Cal.</i> —Lesson 138, <i>Positrons and Pair Production</i>
april	23	Dr. Donald S. Glaser* <i>Professor of Physics, University of Michigan, Ann Arbor, Mich.</i> —Lesson 142, <i>Bubble Chambers</i>
april	26	Dr. I. I. Rabi* <i>Professor of Physics, Columbia University, New York, N.Y.</i> —Lesson 145, <i>Molecular Beams</i>
april	30	Dr. Felix Block* <i>Professor of Physics, Stanford University, Stanford, Cal.</i> —Lesson 147, <i>Nuclear Resonance</i>
may	6	Dr. Lisa Meitner <i>Bragevagen, Stockholm, Sweden</i> —Lesson 151, <i>Discovery of Fission</i>
may	10	Dr. Glenn Seaborg** <i>Chancellor, University of California, Berkeley, Cal.</i> —Lesson 155, <i>Transuranium Elements</i>
may	16	Dr. Edwin McMillan** <i>Director of Radiation Laboratory, University of California, Berkeley, Cal.</i> —Lesson 159, <i>Elementary Particles</i>

* Nobel Laureate in Physics

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■ Textbook Information

It is essential that each person wishing to gain the most from this course has a suitable study and reference text. For this purpose the following text is recommended:

WHITE, MODERN COLLEGE PHYSICS, 4th edition, 1962
*Published by D. Van Nostrand Co., Inc.,
120 Alexander St.
Princeton, N. J.*
(price \$9.75) 755 pgs.

The references given below each of the schedules on the preceding pages refer to this text and may be considered as homework assignments. If time permits, other problems than those specifically assigned should be solved, too. Answers, given for half the problems in the textbook, appear in parenthesis at the end of the problems. Most of these answers are correct. Rarely will an incorrect answer be given. (Authors and teachers are human beings, however, and occasionally make mistakes.)

Textbooks for those registered for credit may be purchased at local colleges. Others please order textbooks directly from the publisher.